M.Tech. Synopsis

Microstructural and Mechanical Characterization of Graphene Reinforced Aluminium Composite Prepared by P/M Route

Sreearravind M

School of Mechanical Engineering, SASTRA Deemed to be University, Thanjavur, Tamil Nadu, India.

Research Supervisor: Dr.Peddavarapu Sreehari

Assistant Professor – III, School of Mechanical Engineering, SASTRA Deemed to be University, Thanjavur, Tamil Nadu, India.

Objective

The study aimed to fabricate and evaluate aluminium–graphene nanoplatelet (GNP) composites using powder metallurgy to enhance the mechanical and physical properties of pure aluminium, particularly its strength and wear resistance. The work focused on optimizing the GNP content and sintering temperature to achieve a uniform dispersion and effective load transfer in the aluminium matrix.

Methodology

- Materials Used: Pure aluminium (Al) as matrix; GNPs at 2 wt%, 3 wt%, and 4 wt% as reinforcements.
- Processing:
  - High-energy ball milling at 200 rpm.
  - Sintering at three different temperatures: 500°C, 550°C, and 600°C.
  - Hot extrusion at 0.0667 m/s to densify and refine the microstructure.

Characterization Techniques:

- Microstructure: Optical microscopy and SEM.
- Mechanical Properties: Rockwell hardness, tensile testing, pin-on-disc wear test.
- Density: Archimedes principle and dimensional measurements.

Key Findings

- Microstructure: SEM revealed homogeneous dispersion of GNPs, with improved interfacial bonding at 550°C.
- Mechanical Properties:
- Al-3wt% GNP composite sintered at 550°C exhibited optimum UTS and ductility, supported by dimple fracture morphology.
- Pure Al showed higher elongation, but lower strength.
- Density: Increased sintering temperature led to improved densification, especially in 4wt% GNP samples.
- Wear and Hardness: Reinforced samples showed higher hardness and wear resistance than pure Al.

Conclusion

Among all the processed variants, the Al–3wt% GNP composite sintered at 550°C exhibited the best balance of strength, ductility, and density. The study concludes that moderate GNP reinforcement and optimal sintering temperature are crucial for tailoring Al-based nanocomposites for structural applications. This work demonstrates a scalable approach to developing lightweight, high-performance aluminium composites for potential aerospace and automotive applications.